The opinion in support of the decision being entered today was not written for publication and is not binding precedent of the Board.

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Ex parte YOUICH ISHIMURA and YOSHIFUMI TOMOMATSU

Appeal No. 2005-0285
Application No. 09/881,675

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U.S. PATENT AND TRADEMARK OFFICE
BOARD OF PATENT APPEALS
AND INTERFERENCES

HEARD: May 4, 2005

Before KRASS, BARRY, and SAADAT, Administrative Patent Judges.
KRASS, Administrative Patent Judge.

DECISION ON APPEAL

This is a decision on appeal from the final rejection of claims 1-10.

The invention is directed to a field-effect semiconductor device. In particular, an insulated gate bipolar transistor is provided whereby nitrogen is included in a barrier metal layer for improving threshold voltage characteristics after annealing processing.

Representative independent claim 1 is reproduced as follows:

1. A field-effect semiconductor device having a semiconductor layer of a first conductivity type, a collector

region of a second conductivity type that is formed beneath said semiconductor layer and equipped with a collector electrode on its lower surface, a base region of the second conductivity type that is formed as part of the upper surface of said semiconductor layer, at least one pair of emitter regions of the first conductivity type that are formed as part of the upper surface of said base region, an insulating layer that is formed to contact said base region that is located between said emitter regions and said semiconductor layer, a gate electrode that is placed on the upper surface of said insulating layer, an interlayer insulating film that is formed to cover said gate electrode, a barrier metal layer that is formed to continuously contact said interlayer insulating film, base region, and emitter regions, and an emitter electrode that is formed on the upper surface of said barrier metal layer, characterized in that said barrier metal layer that is formed between said emitter electrode and said interlayer insulating film comprises a layer containing nitrogen.

The examiner relies on the following references:

Kim et al. (Kim)	6,229,166	May 8, 2001
Sakurai et al. (Sakurai)	5,962,877	Oct. 5, 1999
Okamoto et al. (Okamoto)	4,903,117	Feb. 20, 1990
Ichii, et al. (Ichii) (Japanese document)	11-284176	Oct. 15, 1999[1]

In addition, the examiner relies on the admitted prior art [APA] of Figure 6 of the instant application.

Claims 1-10 stand rejected under 35 U.S.C. §103. As evidence of obviousness, the examiner offers Sakurai, the Japanese document, and Okamoto with regard to claims 1-3, and 5,

[1]We rely on an English translation of this Japanese document prepared by the Ralph McElroy Translation Company for the United States Patent and Trademark Office, for our understanding of this reference.

adding Kim to this combination with regard to claim 4. In addition, the examiner offers APA, the Japanese document, and Okamoto with regard to claims 6-8, and 10, adding Kim to this combination with regard to claim 9.

Reference is made to the briefs and answer for the respective positions of appellants and the examiner.

OPINION

In rejecting claims under 35 U.S.C. §103, the examiner bears the initial burden of presenting a prima facie case of obviousness. See In re Rijckaert, 9 F.3d 1531, 1532, 28 USPQ2d 1955, 1956 (Fed. Cir. 1993). To reach a conclusion of obviousness under §103, the examiner must produce a factual basis supported by a teaching in a prior art reference or shown to be common knowledge of unquestionable demonstration. Our reviewing court requires this evidence in order to establish a prima facie case. In re Piasecki, 745 F.2d 1468, 1471-72, 223 USPQ 785, 787-88 (Fed. Cir. 1984). The examiner may satisfy his/her burden only by showing some objective teaching in the prior art or that knowledge generally available to one of ordinary skill in the art would lead the individual to combine the relevant teachings of

the references. In re Fine, 837 F.2d 1071, 1074, 5 USPQ2d 1596, 1598 (Fed. Cir. 1988).

In the instant case, with regard to independent claim 1, the examiner asserts that Sakurai discloses a field effect semiconductor device, in Figure 9b, having a semiconductor layer 2 of a first conductivity type (n-type), a collector region 1 of a second conductivity type (p-type) that is formed beneath the semiconductor layer and equipped with a collector electrode 13 on its lower surface, a base region 3 of the second conductivity type that is formed as part of the upper surface of the semiconductor layer, at least one pair of emitter regions 4 of the first conductivity type, formed as part of the upper surface of the base region, an insulating layer 10 that is formed to contact the base region that is located between said emitter regions and the semiconductor layer, a gate electrode 11 that is placed on the upper surface of the insulating layer, an interlayer insulating film 14 that is formed to cover the gate electrode, and an emitter electrode 12 that is formed over the interlayer insulating film, base region, and emitter regions.

We agree. We also agree with the examiner that Sakurai does not disclose a barrier metal layer formed to continuously contact

the interlayer insulating film, base region, emitter regions, and under the emitter electrode.

The examiner relies on the Japanese document, specifically Figure 2, for a teaching of a barrier metal layer 21 of molybdenum silicide with a thickness of more than 60nm formed to continuously contact an interlayer insulating film 12, base region 2, emitter regions 3, and under an emitter electrode 20 of aluminum. From this teaching, the examiner concludes that it would have been obvious to modify Sakurai's structure by forming the emitter electrode 12 of aluminum and providing a barrier metal layer having a thickness of more than 60 nm "so that the emitter electrode of aluminum provides relatively low resistivity and low cost, and the barrier metal layer continuously contacts said interlayer insulating film, base region, and emitter regions to eliminate silicon residue and prevent aluminum diffusion into the silicon substrate" (answer-page 4).

The examiner recognized that this modified structure of Sakurai still did not disclose a barrier metal layer formed of titanium nitride, but, asserts the examiner, molybdenum silicide and titanium nitride are "barrier materials known in the art and routinely used to form barrier metal layer in semiconductor

device as shown for example by Okamoto...(see Fig, 1 and col. 3, lines 3-15) to prevent spiking in the junction between the emitter electrode and the silicon substrate, to obtain low resistance ohmic contact and to serve as an excellent diffusion barrier between aluminum and silicon" (answer-pages 4-5).

Therefore, concludes the examiner, it would have been obvious to have selected either one of molybdenum silicide or titanium nitride as a suitable barrier material for the barrier metal layer of the modified Sakurai structure, "since it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the intended use as a matter of design choice" (answer-page 5).

For their part, appellants contend that the examiner has failed to establish the obviousness of a barrier metal layer formed between the emitter electrode and the interlayer insulating film and including a layer containing nitrogen, and that the examiner has not provided a sufficient motivation for making the proposed combination.

We agree with the examiner that the subject matter of claims 1-3, and 5 would have been obvious, within the meaning of 35 U.S.C. §103, based on the applied references.

The examiner admits that the primary reference to Sakurai fails to identify the claimed barrier metal layer. But, the Japanese document shows a barrier layer 21, formed between an emitter electrode 20 and an insulating film 12, in Figure 2, and the Japanese document uses an emitter electrode of aluminum and a barrier layer of molybdenum silicide "because it has small contact resistance with silicon, can stand high-temperature heat treatment, and is conformable with the conventional silicon process" (page 4 of the English translation). Moreover, this barrier layer in the Japanese document is employed to prevent silicon diffusion into an aluminum emitter electrode and preventing the lowering of "the main breakdown voltage yield" (page 4 of the English translation). Thus, the skilled artisan is taught that where aluminum is used for the emitter electorde, it would be wise to employ a barrier metal layer to prevent silicon diffusion.

Sakurai is silent as to the material used for the emitter electrode 12, and there is no indication that Sakurai would suffer from the same problem that the Japanese document seeks to solve, i.e., diffusion of silicon into an aluminum emitter electrode. However, skilled artisans would have recognized that

an emitter electrode may be made from many conductive elements, such as polysilicon, or metals, such as aluminum (the Japanese document teaches the use of aluminum for such electrodes). The skilled artisan would also have recognized that where materials such as polysilicon, for example, are used, no barrier metal layer would be needed because silicon diffusion would not be a problem. However, where metal materials, such as aluminum, are used as the emitter electrode, as in the Japanese document, there would be a problem which a barrier metal layer would solve.

Accordingly, it is clear to us that the artisan would have recognized that although Sakurai is silent as to the material of emitter electrode 12, various suitable materials were known, including aluminum, as taught by the Japanese document. Thus, it would have been obvious to the artisan to form Sakurai's emitter electrode of aluminum, and to use a barrier metal layer, as taught by the Japanese document, in order to avoid problems with silicon diffusion.

From the Japanese document, the skilled artisan is taught that the barrier metal layer should be formed of molybdenum silicide. However, Okamoto taught, at column 3, lines 5-10, that a barrier layer of either titanium nitride or tantalum nitride

may be substituted for molybdenum silicide. Accordingly, the artisan would have been led to use any of these equally obvious choices, including a nitride, which contains nitrogen, as the barrier metal layer, resulting in the instant claimed subject matter.

Thus, the examiner has made a reasonable showing as to why the artisan would have employed a nitride barrier layer (i.e., "a layer containing nitrogen") in the Japanese document as an equally known alternative to the disclosed molybdenum silicide barrier layer. The examiner has also made a reasonable showing as to why the artisan would have been led to employ such a barrier metal layer in Sakurai.

Accordingly, we will sustain the rejection of claims 1-3, and 5 under 35 U.S.C. §103.

Turning to claim 4, this claim adds the limitation that the impurity density of the interlayer insulating film is less than 5 mol %. The examiner relied on Kim for a showing of the use of undoped silicon oxide and impurity doped silicon oxide as dielectric materials to form interlayer insulating films in semiconductor devices. Specifically, the examiner refers to interlayer insulating film 108, and column 4, lines 7-12, of Kim.

The examiner then concludes that it would have been obvious to select any of the materials disclosed by Kim as a suitable dielectric material for the interlayer insulating film 14 of the modified Sakurai device. The examiner also concludes that since "layer 14 is undoped silicon oxide, the impurity density of the interlayer insulatiing film 14 is inherently less than 5 mol %" (answer-page 6).

For their part, appellants merely argue that Kim does not provide for the deficiencies of the combination of Sakurai, the Japanese document, and Okamoto. Appellants do not address the specific limitation of claim 4, wherein the impurity density of the interlayer insulating film is less than 5 mol %. Since we find, for the reasons supra, that there is no deficiency in the combination of Sakurai, the Japanese document, and Okamoto, and appellants have not convinced us of any error in the examiner's rationale, we will sustain the rejection of claim 4 under 35 U.S.C. §103.

Similarly, with respect to claims 6-8, and 10, appellants merely repeat the argument that the combination of references (this time, appellants' Figure 6 (APA), the Japanese document, and Okamoto) is improper for a lack of motivation to provide a

barrier metal layer between the emitter electrode and the interlayer insulatiing film, wherein the barrier metal layer contains nitrogen. For similar reasons, as discussed supra, we find that the artisan would have been led by the teachings of the Japanese document and Okamoto, to employ a barrier metal layer containing nitrogen between APA's emitter electrode and the interlayer insulating film.

Since appellants have not convinced us of any error in the examiner's position, we will sustain the rejection of claims 6-8, and 10 under 35 U.S.C. §103.

Again, with regard to claim 9, appellants do not specifically argue the limitations of this claim, preferring, instead, to merely repeat the same failed arguments as before. Accordingly, we will sustain the rejection of claim 9 under 35 U.S.C. §103.

The examiner's decision rejecting claims 1-10 under 35 U.S.C. §103 is affirmed.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 CFR 1.136(a).

AFFIRMED

ERROL A. KRASS)
Administrative Patent Judge)

LANCE LEONARD BARRY) BOARD OF PATENT
Administrative Patent Judge) APPEALS AND INTERFERENCES

MASHID D. SAADAT)
Administrative Patent Judge)

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